The change over the years of problem solving skills of pre-service elementary mathematics teachers

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Abstract

One of the aims of instruction is to train individuals who can solve the problem. For that reason, future teachers should have problem solving skills. Thus, the aim of this study is to examine the change over the years of problem solving skills of pre-service elementary mathematics teachers. The participants consisted of 1st, 2nd, 3rd and 4th class of pre-service teachers in Elementary Mathematics Teacher Education Program in Karadeniz Technical University. For each class, three students having low, medium and high academic level were selected. In concordance with the purpose of study, three non-routine problems were asked to pre-service teachers accompanied by clinical interviews. The research lasted for three weeks in second semester of the academic year of 2009-2010 at the Faculty of Fatih Education. In problem-solving process, problem solving strategies used by teachers and teachers’ thoughts are summarized in tables. For the first question; while first-year students haven’t used any strategies, other students have used \textit{making a drawing} and \textit{accounting for all possibilities} strategies. For the second question; while first-year students have only used \textit{making a drawing} strategy, beside this strategy, others have used \textit{organizing data} and \textit{adopting a different point of view} strategy. For the last question; while first-year, second-year and third-year students have used \textit{making a drawing} and \textit{finding a pattern} strategies, second-year, third-year and senior students having high academic level have utilized \textit{organizing data} as well as these strategies and answered the problem. Therefore, it is suggested that problem solving oriented lessons should be heightened so as to improve problem solving skills of pre-service elementary mathematics teachers.

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1. Introduction

Innovation studies that have been carried out on elementary mathematics curriculum both around the world and in Turkey attach importance to problem-solving (Kayan & Çakıroğlu, 2008). Problem solving has been regarded as an inseparable part of mathematics education in the elementary mathematics curriculum that has been implemented in 2005 in Turkey and it has been expressed as a basic skill that students can develop for every subject (Ministry of National Education [MEB], 2005). The new curriculum has adopted an innovative approach about processes of problem-solving mentioning that it is required to develop original solutions rather than to use
algorithmic and rule-based approaches. In this sense, 2005 mathematics curriculum aims to provide student environments in which students can make observation, discover, solve problems and share and discuss their solutions with friends (Kayan & Çakırolu, 2008).

In mathematical point of view, a problem is defined as an issue which is to be solved or shown or the way how it should be solved or shown is not clear at a glance or with available information (Grouws, 1996). For a mathematics teacher, a problem means an attractive question of whose steps or ways of solution students do not know but have necessary preliminary information (Schoenfeld, 1989). In this sense problem-solving not only means finding the result of a mathematics question but also means facing with new conditions and finding flexible, effective and elegant solutions for these conditions (Gail, 1996). Polya mentions an art of solution in the process of problem-solving and asserts that this art can be used as a method for teaching mathematics. According to Polya mathematics is not a heap of ready information but a technique of problem solving which is open to the research of child. Four steps which form the strategy of Polya called “heuristics” are “understanding the problem, devising a plan, carrying out the plan and looking back” (Özsoy, 2005). When these steps are considered, it is seen that a suitable plan shall be conducted for the solution of a problem. In fact devising a plan in the process of problem solving is to develop the suitable strategy. The more suitable strategies individuals develop for the solution the more successful s/he will be in the process of problem-solving.

Studies carried out about elementary students put forward the point that students’ level of problem solving skills are not as it is expected to be (Soylu and Soylu, 2006; Karataş and Güven, 2004). When this situation is considered, it is expected from elementary mathematics teachers and pre-service teachers to have these capabilities and to bring students who have the ability of problem-solving. When the years of elementary periods in which problem-solving skills are obtained are considered, first of all pre-service teachers of elementary mathematics education should have problem solving skills. Although the literature on the problem-solving skills of pre-service teachers of elementary mathematics education is reviewed, there is not enough research about the distribution of these skills over the years. In this respect, the aim of this study is to examine the change over the years of problem solving skills of pre-service elementary mathematics teachers.

2. Method

The method of this research is composed of developmental research model. Developmental researches can be observed under three titles being horizontal, vertical and tendency or prediction studies. In horizontal studies, studies on the sample that is equivalent to it in the life cycle that sample can follow can be conducted simultaneously (Çepni, 2009). Yet this study was conducted by doing horizontal research.

2.1. Participants

The participants consisted of 1st, 2nd, 3rd and 4th class of pre-service teachers in Elementary Mathematics Teacher Education Program in Karadeniz Technical University. For each class, three students having low, medium and high academic level were selected.

2.2. Data collection tools

Clinic interview which is one of the alternative evaluation types was used in order to observe problem solving skills of pre-service teachers over years. To be appropriate ethically, students are encoded in the form of “P1, P2, P3...”

The problems below were used in order to detect the change of problem-solving skills of pre-service teachers and strategies that can be used for these problems are given in Table 1.

<table>
<thead>
<tr>
<th>Problems</th>
<th>Strategies that can be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Mother, father and a child decide to play a game. When two people start playing, the winner continues to play with the rest. The person who plays the both games becomes the winner. Since the father is the oldest among three, he is given the chance to play the first game or not. Make suggestions to father to play the game first or not.</td>
<td>Making a drawing, account for all possibilities</td>
</tr>
</tbody>
</table>
2- Businessman Mr. Gökmen commutes regularly by train in specific days of the week due to his jobs. Whenever he returns from job, he is at the station at 5:00 and his private driver takes him from the station at 5:00 sharp. One day Mr. Gökmen takes earlier train and gets to station at 4:00. He prefers walking to calling his driver; the driver comes across him on the way. He picks Mr. Gökmen up and brings him home immediately. In this way Mr. Gökmen gets home 20 minutes earlier than usual. A few weeks later the train he takes arrives station at 4:24 and the same event happens. How many minutes does Mr. Gökmen save this time?

3- Students in a class make a circle on foot and take a number starting from the left of teacher. The teacher walks behind the students and taps at every other student’s head. Such as 1, 3, 5 etc, tapping to every other student’s head. When a student is tapped, he has to sit down. When the teacher completes the circle, s/he continues the tapping process until one student is left. Which student will be left standing? How can we find the number of students which left standing among students for any number?

The reasons of choosing these problems are their having the quality of expressing the difference of problem-solving skills of pre-service teachers of elementary mathematics education and being rich in problem solving strategies.

2.3. The implementation of data collection tools

Collecting data via clinic review lasted for three weeks in the study conducted at Fatih Faculty of Education in the second semester of 2009-2010 academic year. During the interview students were asked to think aloud and if necessary, they were asked questions. Its purpose is to present the students’ problem solving processes.

2.4. Data analysis

In the process of data collection, students were interviewed in advance and the process of problem solving of pre-service teachers were recorded via clinic interviews in a relaxing atmosphere. The collected data were transcribed without any alteration. Later on, the teachers’ views on problem-solving process and problem-solving strategies were summarized in tables. Researchers’ and expert opinions were taken in order to decide on the strategy used by the students.

3. Results

In this section, the students’ views on problem-solving process and problem-solving strategies of students were given in the following tables.

<table>
<thead>
<tr>
<th>Classes</th>
<th>Participants</th>
<th>Views</th>
<th>Supporting sentence</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. class</td>
<td>P1,P2,P3</td>
<td>They stated that the problem was illogical and a game cannot be related with mathematics.</td>
<td>P2: Nonsense, I read it two times and I am trying to understand. P3: I cannot think mathematically, I cannot relate it with mathematics.</td>
<td>No strategy was used.</td>
</tr>
<tr>
<td>2. class</td>
<td>P4,P5,P6</td>
<td>They stated that if father starts playing, the game will finish earlier and if he starts first, his chance of winning will increase.</td>
<td>P4: In conditions which father starts first, the game may finish earlier. The father should start first. P6: When we include father in the games in which father starts first, father should start the game first.</td>
<td>Making a drawing, accounting for all possibilities.</td>
</tr>
<tr>
<td>3. class</td>
<td>P8,P9</td>
<td>They stated that father would increase his chance of being winner if he starts first.</td>
<td>P9: Father should start first because even if he loses again, he still has the chance to play again.</td>
<td>Making a drawing, accounting for all possibilities, intelligent guessing.</td>
</tr>
<tr>
<td>4. class</td>
<td>P10,P11,P12</td>
<td>They stated that father has the equal chance to</td>
<td>P11: I think father has the equal chance to win or not, father should start first so that he can have</td>
<td></td>
</tr>
</tbody>
</table>
While 1st class students did not have any strategies for the solution of the problems, students at other classes who have average medium or high academic grade tried to find the solution by thinking over various possibilities.

Table 3- The students' views on the second problem and the strategies

<table>
<thead>
<tr>
<th>Classes</th>
<th>Participants</th>
<th>Views</th>
<th>Supporting Sentence</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. class</td>
<td>P1, P2, P3</td>
<td>Data given for the solution of the problem are not adequate.</td>
<td>P2: I cannot think of a solution because the driver should also commute, why is not he considered? The commuting process of driver is not considered. I do not know if I think wrong.</td>
<td>Making a drawing, intelligent guessing.</td>
</tr>
<tr>
<td>2. class</td>
<td>P4, P5, P6</td>
<td>After using more than variables for the solution, solution can be attained with ratio and proportion.</td>
<td>P6: There are many variables; I think the data are not adequate. I mean there must be other variables. I think I must consider the question later again. P6: I have 20 minutes in 60 minutes. How many minutes can I have in 36 minutes. I am considering about making proportion since it is said that same processes occur. We see that he gets 12 minutes when we make proportion.</td>
<td>Making a drawing, organizing data, adopting a different point of view</td>
</tr>
<tr>
<td>3. class</td>
<td>P7, P8, P9</td>
<td>First of all it is thought that the data are not adequate, then the solution was attained with ratio-proportion.</td>
<td>K8: When we make correct proportion, it makes 12 minutes but it does not make sense.</td>
<td>Making a drawing, adopting a different point of view</td>
</tr>
<tr>
<td>4. class</td>
<td>P10, P11, P12</td>
<td>It was tried to make an equation but then the solution was found with ratio-proportion.</td>
<td>K12: I’m thinking that he gets home in 20 minutes rather than in 1 hour, let’s say 60 minutes then it is 40 minutes. I do not know how long he walks... (thinking)... If we regard as usual, he will arrive 24 minutes later and be at the station 20 minutes earlier. When it is 4:24 he will arrive 36 minutes earlier. Then if it is 20 minutes per 60 minutes what is the ratio in 36 minutes? Then we do not need information above. But it seems that there is no such thing. Yet it may be if the speed does not change. He will walk a while, and then it is OK. The ratio must be correct. The answer is 12 minutes.</td>
<td>Making a drawing, organizing data, adopting a different point of view</td>
</tr>
</tbody>
</table>

While 1st class students do not make any effort for the problem which they think they do not have enough data, 3rd class students got the correct result although they have the same thought before. Students of 2nd and 4th class have tried to use variable but when they could not find a way out, they reached the solution by ratio-proportion believing that the problem can be solved in an easier way.
4. Discussion

In the conversations carried out with first grade students after clinic interview, all three students stated that such kind of problems are of no good apart from wasting time and they are unnecessary. Furthermore; in postgraduate thesis of Çömlekoğlu published in 2001, students stated that problems should have one correct answer and the questions in course books are efficient to provide the problem solving skill. This situation makes us think that pre-service teachers of first grade would not use open-ended problems which have great contributions to teaching environments but it is still believed that these thoughts of pre-service teachers would change as the years pass.

Another attractive issue is that although pre-service teachers make the verbal explanations of problems correctly, drawings and strategies they choose to explain the situation are wrong. In the study carried out by Kertil (2008), it was observed that pre-service teachers can make verbal explanations; yet, graphical presentation and choice of mathematical models which they use in solving problem are wrong. It was observed that pre-service teachers have difficulty in transmitting mathematical thinking processes which are not formal into formal mathematical language, just like they have difficulty in transmitting from informal models to formal models. This situation may arise from the fact that pre-service teachers have lack of modelling skills.

5. Conclusions and recommendations

When the change of pre-service teachers’ problem-solving skills is considered, while 1st class students cannot develop necessary problem-solving strategies, students at other classes could use suitable strategies although they cannot reach the solution. In this sense, there is a significant difference between the students at 1st class and other classes in the sense of problem-solving. However, as it is expected, there is no significant difference among 2nd, 3rd and 4th class students in the sense of problem solving.

When the strategies used for each problem are considered; most of the students have used the strategies of drawing and finding a pattern. In addition to these strategies, students at the classes have also used the strategies of
accounting all possibilities, adopting a different point of view and organizing data. In fact, students who have high academic level and use these strategies successfully could get the correct answer.

Especially the incident observed in the solution of second problem is the students’ belief towards solving the equation question by using an unknown. However, when students see that there are many variables, they give up or change the solution saying that the solution is not as such. Here, we can see that it is needed to give many sample problems which show students that they cannot come to conclusion only with the solution of equation by using variables.

One of the most important points that comes into prominence in this study is that the pre-service teachers do not understand what they read. At this point, pre-service teachers are suggested to read more books at university years. Furthermore, it is useful to remind pedagogues improving the reading skill during elementary years.

This study puts forward the situation that pre-service teachers are not sufficient enough about problem-solving which is regarded as the core of elementary mathematics education by NTCM (1989) (Çömlekoğlu, 2001). Therefore pre-service teachers should focus on problem-solving based courses in order to improve their problem-solving skills at university years.

References